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A new *Polygonatum* (Asparagaceae) endemic to the Truong Son of southern Vietnam

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Abstract

A new species of *Polygonatum*, *P. annamense* based on evidence from herbarium studies, molecular data, and cultivated material is described and illustrated from upper elevations of the southern Annamite ecoregion where it occurs disjunctly in both the Central Highlands and the Đă Lăt Plateau, Vietnam. It is compared to the morphologically similar *P. punctatum* with which it has been confused, and its relationship to *P. mengtense*, *P. punctatum*, and *P. urceolatum* is discussed.

Key words: Annamites, endemic, Sino-Himalaya

Introduction

Recent collections of a *Polygonatum* Miller (1754: without pagination) (Asparagaceae, Reveal & Chase 2011) by the International Botanical Expedition of the US National Geographic Society (see below) and a living collection (BSWJ9752) from the Central Highlands of Vietnam support the recognition of an undescribed species based on morphological comparisons to *P. mengtense* Wang & Tang (1936: 84) from northern Vietnam (see also Floden 2014), *P. punctatum* Royle ex Kunth (1850: 142) from the Himalaya, and *P. urceolatum* (Shaw 2009: 174) Floden (2014: 112) from northeast Vietnam and adjacent China.

What few collections that exist of *Polygonatum annamense* have remained in a broad morphologically and phytogeographically discontinuous circumscription of *P. punctatum*. This species occurs only in upper elevation cloud forests in a small region of the Annamite ecoregion that includes the Central Highlands and the Đă Lăt Plateau which restricts its available habitat due to the limited area that reaches elevations above 1400 meters. Due to this reduced area of suitable habitat, its presumed rarity, and the limited floristic inventory in Vietnam (and neighboring Laos) it is unsurprising that this novel species has only recently been revealed. Newman *et al.* (2007) reported that there are approximately 14 collections per 100 km² for Vietnam (adjacent Laos is reported at three per 100 km²). In fact, *P. annamense* has been reported as *P. punctatum* from Kon Tum Province (Le Trong *et al.* 1999) though the actual distribution of *P. punctatum* is confined to the Himalayan Mountains (Sino-Himalayan floristic region) (Floden 2014).

Polygonatum is a genus of 60 or more species that are circumboreal in distribution with its center of diversity concentrated in southwest China, the Sino-Himalayan region, and a secondary center of diversity in northeast China, the Koreas and Japan (Tamura 1990). Infrageneric classification of the genus is currently based on phyllotaxy (alternate, opposite, or verticillate), filament shape, and cytology (Tamura 1990, 1991, 1993). Filament shape is mostly correlated to the base chromosome number, although limited molecular work has not supported these morphologically defined groups as monophyletic (Tamura *et al.* 1997; Wu *et al.* 2000). Nonetheless, delimitation between closely related species is best facilitated by the distribution and type of epidermal features of the filaments (Tamura 1990, 1991, 1993).

Two species endemic to the Sino-Himalayan region are unique in being opposite or alternate leaved, evergreen, having a base chromosome number of $x = 15$, red fruit, and an epiphytic habitat. *Polygonatum oppositifolium* (Wallich 1820: 380) Royle (1839: 380) has opposite leaves and not discussed further, whereas *P. punctatum* has leaves that are spirally alternate, opposite, or terminally verticillate. Based on observations of specimens and field observations, and confirmed by molecular data (A. Floden, in preparation), it is part of a clade containing *P. punctatum* and several Indochinese species isolated at high elevations distributed disjunctly in Thailand, northern and southern Vietnam, and southwest China. Latitudinal distribution of the genus ranges from the north of Russia where several taxa occur south into Indochina where *P. annamense* is the southernmost distributed species in the genus.

Description of the new species

Polygonatum annamense A.Floden, sp. nov.

Similar to *Polygonatum punctatum* Royle ex Kunth, but differs in its leaves borne in several whorls, in addition to spirally alternate and opposite at the apex; its white, emaculate and larger perigone, shorter smooth filaments, and terete stem.

Type:—VIETNAM. Kontum Province: Evergreen subcloud primary forest on NE slope of Ngoc Linh mountain system at 2200 m alt. Herb with stem up to 1.5 m high, sometimes epiphyte. Flowers whitish, fruits red, 24 March 1995, L. Averyanov, et al. VH 939 (holotype P!).

Plant perennial. Rhizome moniliform to torulose, 1–2 cm diam. Stem 30–80(–150) cm, red maculate, cataphylls 2–3, 1 caudine cataphyll, membranous, red maculate. Leaves alternate below, alternate, whorled, sub-verticillate to opposite above; elliptic-lanceolate to lanceolate-oblong, 6–15 × 1–4 cm, apex abruptly acuminate, obtuse, glabrous, glossy, base attenuate to a pseudopetiole, whitish, red maculate abaxially, 2–4 mm, 5–7 veins prominent. Inflorescence 1/leaf, axillary, 1–3-flowered, erect to horizontal; peduncle 0.5–1.5 cm, red maculate, pedicel ca. 0.5 cm, red maculate, bracteoles subulate, caducous, ca. 2 mm long. Flowers: perigone white, cylindric, 9–12 mm long, lobes green, 3–4 mm long, filaments inserted just above middle, 0.8–1.1 mm long, tapered downward, glabrous, anthers 1.3–2 mm long, ovary 2.8–3.1 mm long, style 2.5–2.8 mm long, stigma barely trilobed. Fruit red, 4–8 mm diameter.

Phenology:—Flowering April–May, Fruiting September–October, fruits persisting until flowering.

Etymology:—The specific epithet is for the Annamite Mountain ecoregion which includes the Central Highlands of Vietnam and the southern Đà Lạt Plateau, part of Laos and Cambodia. In Vietnam these are known as the Trường Sơn and in Laos, the Sai Phou Louang.

Distribution:—This species only occurs in the upper elevation cloud forests of the Đà Lạt and Kon Tum Plateaus. It is known from Lâm Đồng and Kon Tum Provinces. One collection was from Ta Dung Mountain on the border of Lâm Đồng Province, but potentially in Đăk Lăk Province. It is likely that it occurs in Đăk Nông, Gia Lai, and Quăng Nam provinces. It should be sought in adjacent Laos (Xekong and Attapu provinces) where elevations support subtropical montane broadleaved evergreen forests between elevations of 1600–2100 m. A checklist of the flora of Laos PDR only includes *P. kingianum* Collett & Hemsley (1890: 138) (Newman et al. 2007), though an undetermined Kerr collection (image BM!) was collected on Phu Bia, the highest mountain in Laos.

Additional specimens examined (paratypes):—VIETNAM. Đăk Lăk Province: Ta Dung, 1600m, 17 February 1953, M. Schmid VN 1614 (P!); Lâm Đồng Province: Lac Duong Distr., Lat Commune, Nui Ba (Lang Bian mountain) 12.05N, 108.44E. 1950m, 9 November 2006, S.G. Wu, P.K. Loc, J.Y. Xiang, S.D. Zhang, N.V. Duy & N.T. Vinh WP-1489 (MO!); 29 km to NE from Đà Lạt City, distr. Lac Duong, municipality Da Chay. Primary wet closed broad-leaved cloud forest along main Bi Dup ridge, 12.10N, 108.65E, 1900–2100m, 22 March 1997, L. Averyanov et al. VH3066 (MO!); Đà Lạt, Tixien N34, S 259, 1957 (P); Mt. Lang Biang. Đà Lạt . 1900m, 3 May 1964, M. Schmid s.n., (P!); M Lang Biang, Đà Lạt , 1700m, (271h15h), M. Schmid s.n. (P!); Massif du Bi-Daup, 14 October 1940, Poilane 30911 (P!); 29 km to NE from Đà Lạt City, Dist. Lac Duong, munic. Da Chay. Primary wet closed broad-leaved cloud forest along main Bi Dup ridge at 1900–2100 m. alt., 12.1, 108.483333, 22 March 1997, L. Averyanov, N.Q. Binh, P.K. Loc VH 3066 (MO!); Kon Tum Province: NW slopes of Ngoc Linh mountain system, near Ngoc Linh village, 1200–2500 m, 23 February 1995, L. Averyanov, et al VH 084 (MO!).

Taxonomic relationships:—Morphology of *Polygonatum annamense* including: 1) the distinctly tapered filaments with a gibbous protrusion at the attachment of the anther; 2) urceolate perigone shape; 3) rhizome and root type; 4) phyllotaxy; 5) maculation of the stems and leaves; and 6) molecular data (unpublished data) suggest a closer relationship to its geographically more distant sister species, *P. punctatum*, than it shares with either *P. mengtense* or *P. urceolatum* from northern Vietnam and southwest China. Comparisons of *P. annamense* to *P. punctatum*, which are more similar to one another, are discussed herein while the differences between these two and *P. mengtense* and *P. urceolatum* are presented below (Table 1). Distinguishing features of *Polygonatum annamense* that separate it from *P. punctatum* are its overall larger plant size, terete stems, occasionally whorled leaves throughout the stem, rather than whorled only at the stem apex, and larger, emaculate, and non-urceolate flowers. Stem characters from my observations in this group of *Polygonatum* species show significant differences between the species without much variation within a species. All specimens of *P. annamense* observed and the single cultivated accession shows that the stem is terete throughout

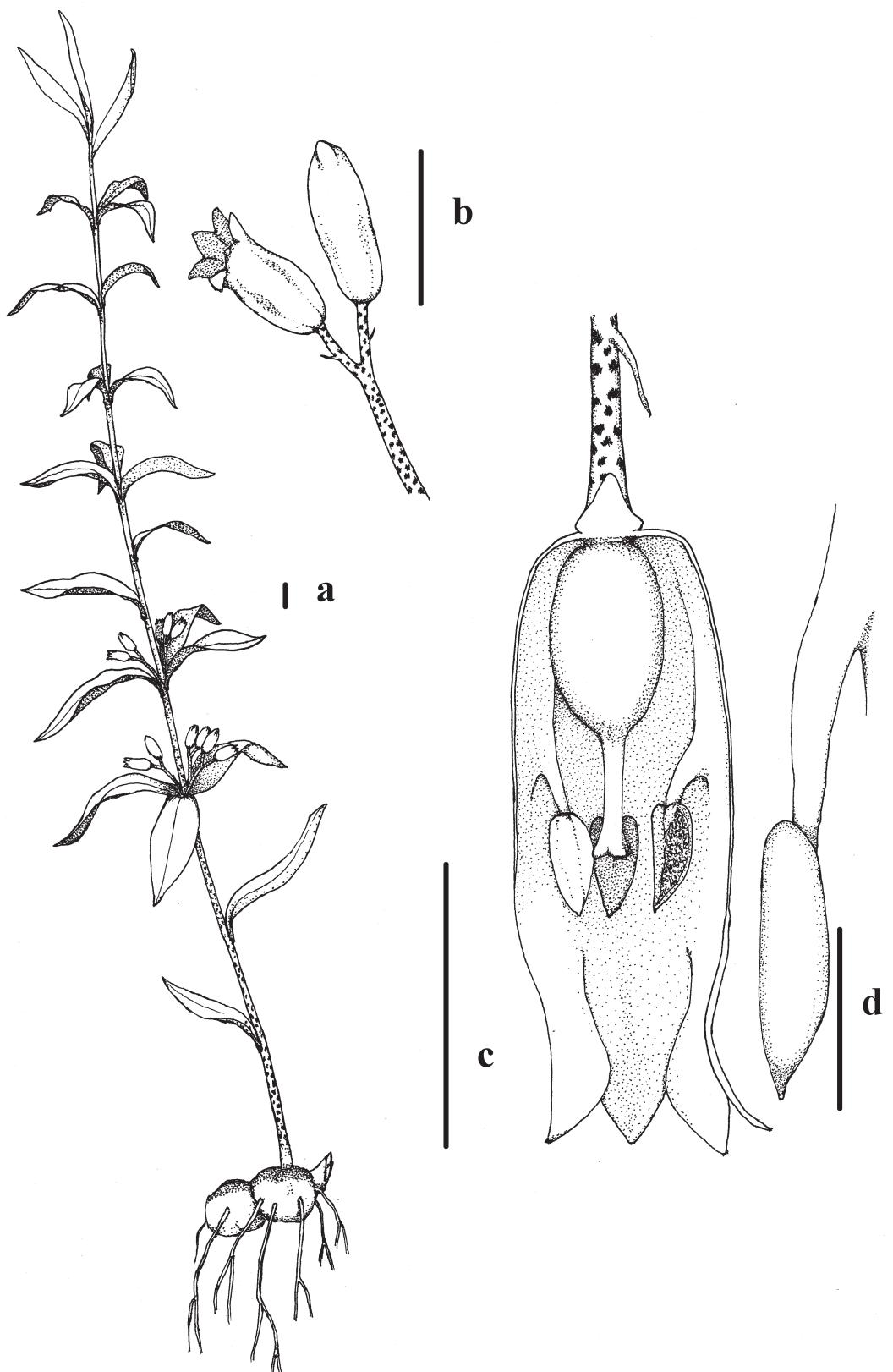


FIGURE 1. *Polygonatum annamense*. a. stem, b. inflorescence, c. perigone, and d. stamen. Scale bars: a & b = 1 cm; c = 5 mm, and d = 0.5 mm. Drawn by the author from living collection BSWJ 9752 (TENN).

and, like many of the species in this group, maculate, at least in the proximal portion. In contrast, *P. punctatum* is prominently sulcate and papillose on the ridges. Phyllotaxy within this group provides some means of separation; *P. annamense* and *P. punctatum* have a mix of alternate leaves borne spirally around the stem, opposite leaves, and sometimes whorls whereas *P. mengtzense* and *P. urceolatum* are distinctly alternate and distichous on arching stems. In



FIGURE 2. *Polygonatum annamense*, holotype at Paris (P), both in flower and the previous seasons stem in fruit, VH 939.

P. annamense and *P. punctatum* the leaves are mostly spirally alternate, but *P. annamense* has leaves in whorls of three on the lower part of the stem, alternate through the middle with an occasional opposite pair and usually terminated by an opposite pair, whereas *P. punctatum* has leaves alternate to opposite along the stem and usually terminally 3-whorled. Both have leaves that are elliptic to lanceolate with reddish maculate spots abaxially and are chartaceous to subcoriaceous in texture. The morphology of the inflorescence and their position on the stem is variable between *P. annamense* and *P. punctatum*. *Polygonatum annamense* has inflorescences that are one to four flowered with no tendency to produce fascicles thus far noted. *Polygonatum punctatum* has inflorescences sometimes in fascicles with several one-flowered pedicels or frequently with a one-flowered pedicel and often a twinned peduncle. Differences observable in the perigone morphology between *Polygonatum annamense* and *P. punctatum* are the insertion level and filament shape. The perigone of the former is larger (10–12 vs. 7–10 mm long), cylindric and not distinctly urceolate, with longer non-reflexed lobes, and without pink maculation always seen in *P. punctatum*. The insertion of the filaments within the perigone tube is near the middle in *P. annamense* and distal of the middle in *P. punctatum*. The shape of the filaments in both species are tapered with a distinct gibbose protrusion at the anther attachment, but the filaments in *P. annamense* are thicker, the taper less pronounced, smooth, and with a smaller, smooth gibbose protrusion while those of *P. punctatum* are more slender with a prominent gibbose protrusion that is papilloose.

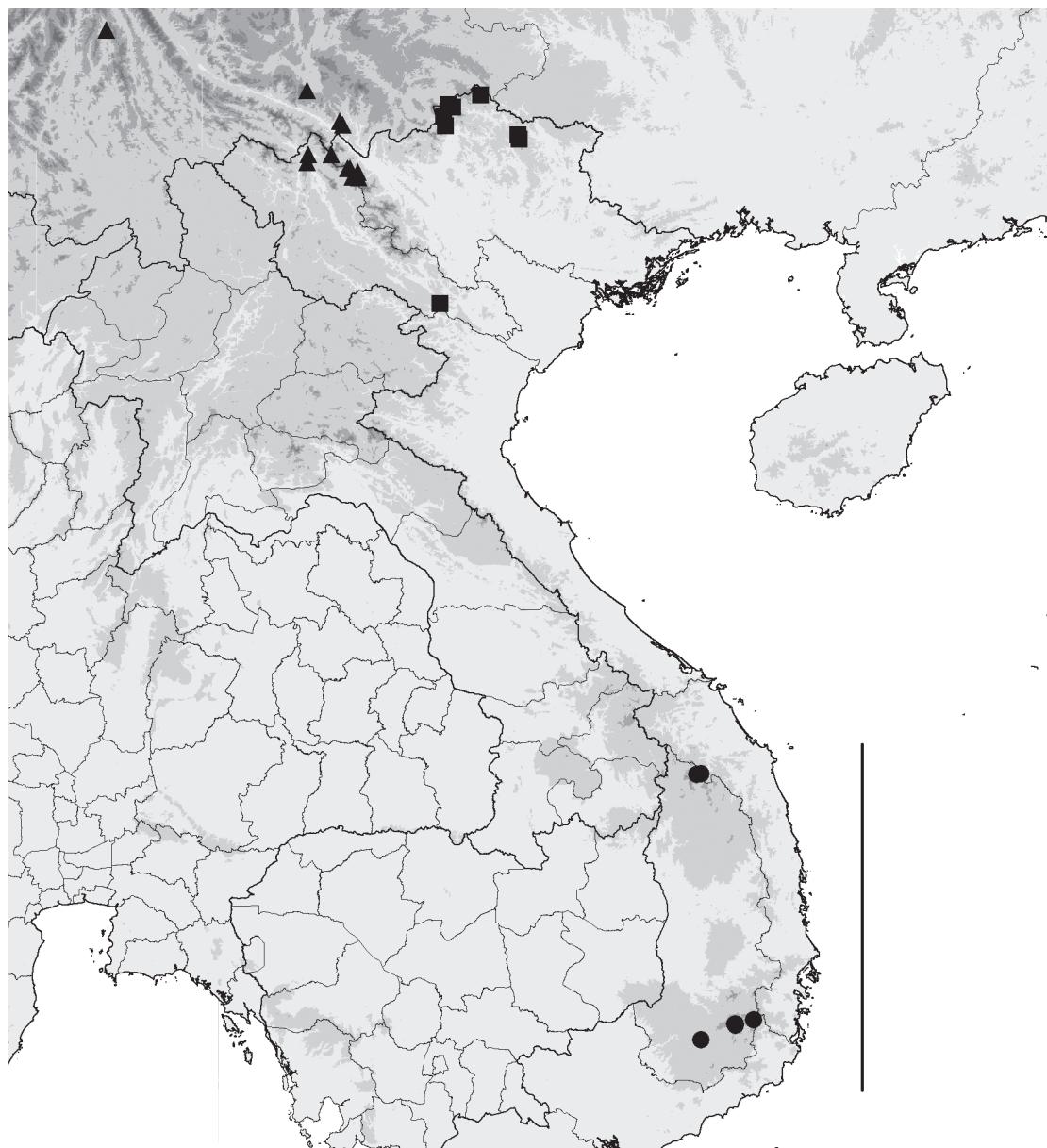


FIGURE 3. Map of the distribution of *Polygonatum annamense* (black circles); *P. mengtzense* (black triangles); and *P. urceolatum* (black squares) in Vietnam. Localities are from GPS coordinates or approximations from label data. Scale bar 500 km.

TABLE 1. Comparison of the relevant morphological characters that distinguish *Polygonatum annamense*, *P. mengtzeense*, *P. punctatum*, and *P. urceolatum*. Morphological data measured from both specimens and cultivated material. All measurements are in millimeters.

species	<i>P. annamense</i>	<i>P. punctatum</i>	<i>P. mengtzeense</i>	<i>P. urceolatum</i>
stem	terete	sulcate, ridges papillose	terete	sulcate, ridges smooth
phyllotaxy	alternate, opposite, and whorled	alternate, opposite, terminally whorled	alternate	alternate
inflorescence	erect or horizontal	horizontal	pendent	deflexed
infructescence	erect	erect	pendent to erect	pendent to erect
peduncle	smooth	ridged	smooth or papillose	smooth
perigone length	10–12	7–10	7–10	10–12
perigone shape	cylindric	urceolate	urceolate	urceolate
perigone color	white	white, pink maculate	greenish-white, greenish and red maculate	white-green
tepal length	3–4	1.5–2	2–2.5	2–2.5
filament insertion	middle	distal of middle	proximal of middle	proximal of middle
filament surface	smooth	smooth	papillose	rugulose
filament gibbosity	smooth	papillose	papillose	papillose
filament length	0.8–1.1	1.1–1.5	0.8–1.4	0.8–1
ovary	2.8–3.1, ovoid	3–3.5, obovoid	1.8–2.5, obovoid	2–2.5
style	2.5–2.8	2–2.5	1.3–2	1.5–2

The description of this new species endemic to the Central Highlands of Vietnam increases the number of species to four in this group of *Polygonatum*. All the species of this group are distributed from the Himalaya south and east into floristically Sino-Himalayan zones as defined by elevation in otherwise Sino-Japanese or Malayan floristic regions (Averyanov *et al.* 2003). *Polygonatum annamense* represents an additional Sino-Himalayan floristic element of the Ngoc Linh Mountain area and the Đà Lạt Plateau. Both are areas of elevated floral endemism and also an intersection of the Sino-Himalayan and Malayan floristic provinces, the former found mostly at upper elevations (Sterling & Hurley 2005, Le *et al.* 1999).

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